

UNITED STATES PUBLIC HEALTH SERVICE

RUPERT BLUE, SURGEON GENERAL

SAFE MILK

AN IMPORTANT FOOD PROBLEM

BY

ERNEST A. SWEET

*Surgeon, United States Public Health Service*

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## SAFE MILK.

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Milk is unquestionably one of the most important of human foods. It contains practically all the elements which man requires for his sustenance and constitutes his sole dependence throughout the first year of life. In later years milk and its products make up a large proportion of our diet and go far toward furnishing the total energy expended in accomplishing man's daily tasks. In one form or another it is available to practically every citizen and there is scarcely a hamlet or home where it may not be secured. It still remains, in proportion to the energy furnished, one of our cheapest and most desirable foods and it is considered indispensable by rich and poor alike. Both its preparation and consumption are untended by waste and its digestibility is such that even the frailest of all ages derive the maximum amount of energy from its use. Rightfully, then, this substance has attained a position in the dietary of the American people practically unequaled by any other aliment.

Yet in spite of these facts, milk is, at least potentially, one of the most dangerous foods which we consume. Instead of producing strength and nourishment, it may engender weakness and death and it is capable of transforming health and vigor into frailty and decay. Annually thousands of babies are ushered to their graves because of impure milk, while other thousands journey through life maimed and injured from its action, tragedies which many of us in our ignorance gaze upon without concern.

### Composition of Milk.

Milk is a substance which varies considerably in composition even in animals of the same species. A mixture of milk from several cows is much more constant in its chemical make-up than that from a single animal, and for this reason is to be preferred for infants. Dairy herds which are well fed and housed as a rule produce a supply richer in its various constituents than those which are improperly cared for.

The basic ingredient of milk is water, the remaining components either being dissolved or held in suspension by this substance. Ordinarily milk contains approximately 87 per cent of water, the laws of the majority of States requiring that 12 per cent of solids be present. Where the amount of solids falls below this average the

purchaser does not receive full value for his expenditure. On this account legal standards have been adopted in practically all communities.

From the food standpoint fat is the most valuable constituent of milk. It is present in the form of an emulsion, the droplets being held in suspension and giving to the milk its normal color, each droplet being surrounded by a thin albuminous envelope which prevents them from uniting. Upon agitation, especially when the cream has stood for several days and the envelope is partially disintegrated, the droplets coalesce and butter is formed. The fats in milk are not all of the same composition, but their properties are similar, although the size of the globules varies. Their decomposition gives to butter its well-known rancid taste. It is now recognized that milk especially rich in fat may cause digestive troubles in children, consequently such a supply may not be entirely suitable for infant feeding, although entirely satisfactory for ordinary consumption.

The amount of fat varies considerably. Many cows produce a milk which contains as high as 5 per cent of fat, while with others the percentage is much lower. The legal standard of the different States varies from 3 to 3.5 per cent, the latter figure being the more common. The output of Jersey and Guernsey cattle is relatively richer in fat than that of other breeds. Holsteins generally produce a milk in which the fat is low in quantity and the emulsification more perfect. For this reason their product is considered a better milk for the use of infants, as fat curds are less apt to form during the process of digestion.

Factories and milk depots which use a large amount of milk pay the producer in proportion to the quantity of fat which the milk contains. Milk "strippings" are richest in fat, this being the product obtained at the very last of the milking, while the first milk drawn is poor in this ingredient. The practice in vogue in many countries of driving the milch animals from door to door for the purpose of dispensing their product, while having many advantages, is thus seen to be not altogether equitable to those first served.

Unfortunately the richness of a milk can not in every instance be determined by the thickness of the cream layer, although most housewives place entire dependence upon this method. Milk which has stood but a short time will necessarily have only a thin stratum of cream, while that which has been agitated may show none at all, the fat being evenly distributed. Again, milk which has been heated beyond a certain temperature shows only a slight cream layer. A third reason why the visual method of determining the fat content is not dependable is due to the fact that in certain instances, even when the cream is present in more than average quantity, it fails to rise to the surface. Finally, the consumer should realize that a deficiency in

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a small amount of fat is not nearly as important as other considerations, such for instance as the presence of disease bacteria, and for this reason it should not receive overemphasis. At milk depots and on large producing farms the amount of fat is definitely determined by chemical means, the principal one of which is the Babcock test.

A number of substances called proteins, of complex chemical composition, are also found in milk and are important as foods, although the amount of energy which they furnish is approximately only half that of the fats. The principal protein is casein, familiar as curds in sour milk. When milk is taken into the stomach the casein is precipitated from its watery solution by the ferment rennin, an ingredient of the gastric juice, and the active principal of rennet, used in cheese making. The casein of cow's milk when precipitated in this manner during the act of digestion forms much larger and tougher curds than the casein of mother's milk and hence is more difficult of digestion. If, however, a small amount of lime water be added to cow's milk the curds formed during digestion more nearly approximate those of human milk. Other proteins, known as albumin and globulin, are also present. When milk spoils (decomposes) these three proteins undergo changes and may, if then taken into the system, cause illness. Proteins are always present even in skim milk, and for this reason milk deprived of its fat still has considerable food value. Skim milk is a good food.

A third important constituent of milk is lactose, commonly known as milk sugar. This substance is similar to ordinary sugar in composition but differs from it in sweetness and other properties. It chars upon heating, thus giving to milk a brown color when the temperature approaches the boiling point. Milk sugar ferments when acted upon by bacteria in much the same manner as cane sugar, the product of this fermentation being lactic acid. The lactic acid is what makes old milk taste sour. It throws down the casein in milk in the form of curds. The amount of milk sugar in mother's milk is approximately 7 per cent, while that of cow's milk is less than 5 per cent. Lactose has a highly important food value, furnishing about the same amount of energy as protein, and is very easily absorbed. It is to be preferred over other sugars in the preparation of infants' foods.

In addition to the substances already mentioned milk contains certain ferments which are supposed to assist in its digestion. These ferments are killed by temperatures approaching the boiling point, and this has led a number of scientific investigators to believe that boiled milk is less nutritious than raw milk. The difference, if it does exist, is, however, so slight that it can be ignored by the consumer. Various salts of lime, soda, and potash are also present in milk.

### Abnormal Qualities of Milk.

Bitter milk may be caused by certain plants or weeds eaten by cows, or it may be due to the action of bacteria. In the first instance it is bitter when drawn, while in the second the bitterness does not develop until several hours later. Bitter milk is never desirable, although it may not be directly injurious.

A change in the color of milk may be brought about by a number of different causes. It may be due to the consumption of certain plants which contain a large amount of pigment, or it may result from contamination with various bacteria, producing either a red or blue discoloration. Far the most frequent cause of discoloration, however, is the presence of blood resulting from inflammatory disease of the udder. The use of milk of this character is dangerous; therefore any variation from the normal color should be recognized as a warning signal.

Slimy milk may be due to inflammation of the udder, to age, or to the presence of bacteria. It is best that milk showing this property be rejected as unfit for consumption.

Milk readily absorbs odors, and the flavor may be modified by various articles with which it comes in contact. Thus milk which is kept in the same refrigerator with foods which possess a distinctive odor often develops the characteristic scent, even when the exposure has been of short duration. Cattle which have been fed on fermented foods, ensilage which is too green, moldy grain, and distillery waste almost invariably secrete milk of a distinctive odor. The characteristic cowy taste which is so common is due both to the absorption of odors from the stable and also to the presence of stable dirt and manure; when pronounced it indicates carelessness and lack of cleanliness at the dairy.

### Milk Adulteration.

The addition of water is unquestionably the oldest method of adulterating milk. In proportion to the amount of liquid added it causes a diminution in the various elements; but, what is more important, if the water is contaminated it may bring about the development of typhoid fever, dysentery, and other water-borne diseases. If the water is from a reliable source the adulteration is not a menace to health. There are various methods for determining adulterations of this character, but the housewife must necessarily depend upon the fallacious test of the general appearance of the liquid and the thickness of the cream layer, which are frequently deceptive. Chemists have at hand specific gravity and other tests which clearly indicate whether or not milk has been treated by the addition of water.

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Skimming is the least objectionable form of adulteration from a health standpoint and probably the most common. It consists in the removal of but one element of the milk, that is the fat, either by the use of a separator or by abstraction of the top milk or cream. In addition to a legal standard for milk the laws of a majority of States provide that no cream shall be removed. So long as the legal standard is maintained the latter provision is not generally enforced.

Milk is occasionally adulterated with coloring agents in order to give it the appearance of richness and to avoid detection when either skimming or watering have been practiced. Caramel, annatto, and certain dyes, none of which in average amounts is particularly injurious, are used for this purpose. There is a prevalent notion that chalk has extensive vogue both as a coloring and thickening agent, but as a matter of fact milk is probably never adulterated in this manner, as immediate detection would result.

Milk is an exceedingly perishable product, comparing in this respect with fish, meat, and oysters. As we shall later see it spoils most readily if not maintained at a proper temperature and if cleanliness is not exercised in its handling. Certain chemicals have been found to delay or retard this decomposition and these substances, known as milk preservatives, were at one time widely used by dealers to preserve their product or to prevent further decomposition where such changes have begun. These chemicals are a substitute for cold and cleanliness, the only satisfactory preservatives, and their use is a plain indication that the ordinary and customary precautions in handling have not been exercised. Of the numerous substances employed for this purpose, a number are sold to dealers under trade names, but they usually consist of formalin, borax, boric acid, chemicals known as fluorides or other antiseptics or germicides. These adulterants are easily recognized by suitable tests and it is customary for all boards of health to make systematic examinations for their presence.

#### ACCIDENTAL IMPURITIES.

From a health standpoint the accidental impurities of milk are much more important than those just discussed, the adulterations intentionally added by man. Illness seldom arises either from the abstraction of any element contained in milk or by the addition of chemicals thereto, but serious maladies may result from contamination which is accidental, though nevertheless preventable. Carefulness in production and handling is more to be esteemed than the strictest honesty in composition, although in the past the average person has given more consideration to the former than to the latter.

Milk is invariably produced in surroundings which favor the introduction of dirt. There is probably no other food consumed

having its source where filth occurs in greater abundance or where the filth is of such a nature. It has been truly said that if milk were a transparent rather than an opaque fluid the visual evidence of the contamination which oftentimes results would be so pronounced that people would revolt at the thought of its consumption. It is not to be expected then that this substance, one of the most perishable of all foods and one of the most susceptible to the influence of dirt and bacteria, can be obtained in a pure state without regard to strict rules of cleanliness.

The dirt most commonly found in milk is manure, but this is often mixed with hair, dust, flies, and even foreign material from human sources. It is probably safe to state that milk is seldom, if ever, produced without being contaminated to a greater or less degree by one of these substances, depending upon the care exercised by the milker and the conditions under which the supply is secured. This contamination is not in every instance visible to the eye, as a certain amount of the material is almost immediately dissolved, but whether in solution or suspension it is at all times highly undesirable. Frequently the dirt is present in sufficient amount to impart a characteristic taste to the liquid and can be found as a sediment in the bottom of the container. Dirt of the character described if present in excessive quantity is always a plain indication that at some stage in its journey from producer to consumer reasonable care and cleanliness have not been exercised. The absence of dirt, although a favorable indication, by no means signifies that a milk is safe for consumption, inasmuch as the dirt may have been removed by straining, filtering, or centrifuging, or even have been dissolved, leaving behind the more injurious bacteria which it may contain.

A simple test for the presence of visible dirt can be performed with absorbent cotton. A fairly tight wad or disk of cotton is placed in the narrow neck of a container and a pint or more of the fluid to be tested is gradually filtered through. The discoloration of the cotton upon its removal is in proportion to the amount of undissolved dirt present, ordinarily clean milk showing only the slightest brown discoloration. A visible sediment in milk which has stood for two hours is always sufficient reason to justify condemnation.

#### BACTERIA IN MILK.

Invariably accompanying and intimately associated with dirt in milk are other substances far more injurious than dirt in itself. These are the bacteria. All milk contains bacteria in greater or less degree. These organisms may be derived from the udder of either diseased or normal animals, they may have their source in filthy conditions of the stable, or they may occur from contamination in han-

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dling. As milk is an ideal medium for the growth of bacteria, affording the necessary elements for their development, immediate multiplication ensues if conditions are favorable and a supply which originally contained but a few hundred bacteria to each cubic centimeter (one-fourth of a teaspoonful) may within a few hours be transformed into one containing thousands or even millions. This rapid multiplication of organisms in a relatively short space of time often modifies the entire character of a milk supply.

Most of the bacteria which find their way into milk are altogether harmless, while a few are exceptionally dangerous. For example, the lactic acid bacilli can almost be regarded as normal constituents, as they are practically always present, even in supplies which we regard as perfectly pure. They bring about fermentation of the milk sugar, transforming it into lactic acid, which when present in sufficient quantity precipitates the casein and produces what is known as sour milk. These bacteria are useful in the manufacture of butter and cheese and they cause no ill effects when taken into the system; in fact, certain organisms of this group are believed to be beneficial and are sold under various names for the prevention of intestinal fermentation, and the favoring of longevity, although their usefulness as far as the latter object is concerned is problematical. The lactic acid bacteria are also valuable in another way in that they serve to check the multiplication of injurious organisms. The number of lactic acid bacilli is always in proportion to the age of the supply and the amount of dirt which it contains, hence milk produced in clean surroundings remains sweet for a longer period than that otherwise obtained.

Other forms of bacteria are concerned in the putrefaction of milk, a change which fortunately usually occurs only subsequent to souring.

The third group of bacteria, the disease-producing variety, is much more important, as their presence may bring about serious epidemics of any one of a number of diseases. These bacteria, in contrast to those which we have considered, produce no change in the milk in which they thrive. Therefore a liquid which is perfectly normal in color, appearance, and taste may contain organisms of this nature capable of causing serious and even fatal illness. The prevention of the entrance of these germs is one of the great problems of milk production.

#### **Influence Affecting Bacterial Growth.**

The growth of bacteria of both the disease producing and harmless varieties is greatly influenced by temperature. Heat is necessary for the multiplication of all germs, but certain varieties thrive best

at one temperature while others multiply rapidly at another. As a rule the bacteria contained in milk increase prodigiously at a temperature of from 70° to 100° F., while their growth is retarded at 50° F. or under, which is or should be the temperature of the ordinary household refrigerator. For example, two samples of milk containing the same number of bacteria are maintained, one at a temperature of 50° and the other at 70°. At the end of 24 hours the first sample will contain at the most only five or six times the original number of bacteria while the second sample will show five or six thousand times the original number. A change of only a few degrees of temperature will thus bring about an enormous difference in the bacterial life and may convert a milk which is relatively safe for consumption into one which is extremely dangerous. The importance of this fact should of course be apparent to every person concerned in the handling of milk. The maintenance of all supplies at a temperature where bacterial development is retarded is absolutely essential if a dependable milk is to be obtained. Particularly is this true in the summer season when natural temperatures are high.

A fact of extreme importance relating to the influence of heat upon bacteria is the temperature at which organisms are killed. When milk is exposed to a temperature of 145° F. and is held at that point for 30 minutes all disease-producing organisms are destroyed; if the supply is then immediately chilled further multiplication of the remaining germs is temporarily inhibited. As we shall later see, this is taken advantage of in the process known as pasteurization.

Time is another factor which greatly influences the development of bacteria, the two conditions, time and temperature, working hand in hand. Milk freshly drawn from healthy cows contains relatively few organisms, but after a lapse of several hours, even when the sanitary conditions are of the best and the temperature is low some multiplication occurs. Ordinarily milk reaches the consumer within 48 hours after it is produced; if this period is lengthened the quality will be proportionately endangered, and this notwithstanding the proper chilling and handling of the supply. Fresh milk is therefore always to be considered preferable to that which is not recently drawn, although freshness is by no means proof of purity.

#### The Number of Bacteria in Milk.

One of the means used for determining the purity of a milk is the estimation of the number of bacteria present. This is done by counting, a procedure which is now common in all health laboratories. The bacterial count of fresh milk is a measure merely of the cleanliness of a particular supply and the cleanliness is to a degree a

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measure of the safety. It would, of course, be more desirable if we could determine the safety of a given sample directly without regard to the cleanliness, for, as we know, not all dirt is dangerous, neither are all forms of bacteria harmful. In the present state of our knowledge, however, this is impossible. Therefore in order to avoid dangerous dirt it is necessary to avoid all dirt. Milk with a low bacterial count is considered safest and best, while that with a high count may be actually dangerous.

As stated, the number of bacteria in milk just from the cow is always in proportion to the cleanliness, but in market milk the temperature at which the product has been maintained, the amount of handling it has undergone, and the age, are also factors in determining the number of bacteria present. If the supply is fresh and has been obtained with strict conformity with the rules of cleanliness, if the containers have been properly cleansed, and if exposure to dust and dirt has been kept at a minimum, the bacterial count will be low. On the other hand milk which has been shipped for long distances without proper chilling, that which has come in contact with non-sterile containers, or supplies which have been carelessly handled at any part of their journey from producer to consumer, will show a high count.

In conformity with the knowledge that milk containing large numbers of bacteria is due to carelessness in production or handling and may be harmful, boards of health have deemed it necessary, as a measure of safety, to limit the number of bacteria which milk offered for sale may contain, and to make accurate counts at stated intervals to see that this limit is not exceeded.

Just what limit is to be placed upon the number of bacteria in milk is a matter for determination by the health authorities, after due consideration of the difficulties which the producers and purveyors may encounter. A low count for a city would be a high count for a country milk. The climate, the season of the year, transportation facilities and availability of ice are all matters to be considered in fixing a standard. In small communities where milk is produced within a few miles of the point of delivery bacterial counts of 100,000 may be considered excessive, whereas in large cities receiving their supplies from places perhaps a hundred or more miles distant counts on raw milk below 100,000 are rare.

#### DISEASES WHICH MAY BE CONVEYED BY MILK.

Outbreaks of disease brought about by milk usually present certain distinguishing characteristics which serve to determine their source. For the most part the disease is confined to the milk route of a certain dealer; that is, to families using a particular supply. Instead of the

epidemic developing gradually and the number of cases increasing from day to day, it comes on suddenly, the maximum number of cases frequently being recorded at the very onset. The subsidence may be nearly as rapid. Only those who have actually used the milk or its products are attacked. People in the better walks of life are if anything more subject to the disease than those in poorer circumstances, while women and children are more frequently made ill than others, this because these classes are more apt to be milk consumers. Upon the closing of the dairy or the pasteurization of the supply the epidemic is immediately terminated. These facts, in themselves, furnish conclusive proof of the source of the disease, but in many instances the person responsible for the infection can be identified by the health officer and at times the infectious agent can even be recovered from the milk.

Milk derived from animals which are themselves suffering from disease is unfit for consumption. Supplies obtained from cows afflicted with anthrax, tuberculosis, lumpy jaw, or other infections should not be used. However, milk which has its origin in perfectly healthy stock may to an even greater extent be responsible for illness than that from diseased stock, a fact which we are quite too slow to appreciate.

*Typhoid fever.*—One of the most fatal diseases conveyed by milk is typhoid fever. This is an infection peculiar to man due to a specific germ, the typhoid bacillus, which gains entrance to the system through the mouth, the poisons generated during its multiplication producing the characteristic symptoms of the disease. Every case of typhoid fever arises from a preexisting case, and milk only serves as one of the means of transference of the bacilli from infected persons to those who are well, water and other foods likewise frequently conveying the infection. The contamination in all cases is accidental. Whenever typhoid organisms obtain access to milk they increase rapidly in number, particularly if the temperature is favorable, so that within a few hours they may contaminate an exceedingly large supply, thus distributing the infection far and wide. The rapid growth of bacilli which follows contamination with typhoid organisms produces no recognizable changes, and a fluid which is perfectly normal in taste, sweetness, and appearance may be teeming with organisms of this nature.

The typhoid bacillus is killed by heat, but is quite resistant to cold, hence the freezing of milk and cream affords no protection to consumers, epidemics of typhoid having frequently been traced to infected ice cream. Butter, cheese, and other dairy products may not be free from danger, although it is considered that they are much less apt to convey the infection than milk itself.

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The organism causing typhoid fever gains entrance to milk in various ways, and contamination may occur at any point on the route from the farm to the consumer. Infection most frequently takes place, however, at the dairy. The pollution is not always direct—that is, it may be transferred by secondary objects, so that it is entirely unnecessary for a person actually ill of typhoid fever to come in direct contact with a milk supply for contamination to be brought about. The improper disposal of human excreta on dairy farms strongly predisposes to the development of typhoid infection in milk and is a condition never to be tolerated. Flies and other insects having access to unscreened and unprotected privies may travel to the stable or milk house carrying with them the contagion of the disease; it should not be forgotten that milk may also be befouled in this identical manner both in the home and at places where it is offered for sale. Another source of contamination at the dairy is polluted water. Seepage from privies and outhouses may obtain entrance to wells, a condition not at all uncommon in country districts, and the polluted water from these sources may be used in washing the milk pails or cans, thereby transferring the typhoid germ directly to the milk.

The occurrence of a case of typhoid fever among the employees or members of a dairyman's household, or of any other person engaged in the handling of milk, is always a matter of grave concern and calls for the strictest regulation on the part of the health department. Persons engaged in caring for such cases may contaminate the hands with the infection, thus polluting the supply. Frequently those who are in the early stages of typhoid fever are able to be about, attending to their daily duties, and under these circumstances they constitute an especially dangerous class. The most insidious agent of all, however, is the typhoid carrier, the person who has recovered from the disease but who continues to discharge bacilli in his excretions. Such a one may actually be working as a milker or engaged even in the care of the supply, thus affording, if strict cleanliness is not practiced, the greatest opportunity for infection. With these facts in view one can easily understand how important it is for a health department to possess knowledge of the occurrence of every case of infectious disease wherever milk is produced or handled.

Whenever typhoid fever develops in a community in epidemic form milk contamination should be considered; in fact, it should be a matter of consideration when the disease is not epidemic, as many of the scattered cases are doubtless due to this cause, although they are more difficult to trace to their source than those affecting large numbers. In all instances of this character the milk should be pasteurized, boiled, or its use altogether discontinued, the epidemic at once ceasing when this is done.



As a rule milk epidemics of typhoid fever present characteristic features which are highly significant to the trained sanitarian. Often the investigator is able to trace the contagion to the dairy concerned and in many instances to the very person who constitutes the source of the infection and from whom the bacilli are being derived. In nearly all instances not only is it found that some person suffering from the infection is living on the premises but that there has been in addition gross carelessness in the methods of handling the supply. Cleanliness is therefore a most important element in safeguarding against this far too common infection.

*Malta fever.*—A second disease conveyed by milk but one which is merely of academic interest to residents of most sections of this country is Mediterranean fever (Malta fever). As the name indicates Mediterranean fever is so called because of its occurrence in the countries bordering the Mediterranean Sea, but foreign countries, including Mexico and the United States, have been invaded by the infection. The disease primarily affects goats, the chief source of the milk supply in many European countries, and is due to a specific microorganism. When taken into the system the organism gives rise to fever continuing over many weeks, debility, rheumatic pains, and swelling of the joints, the infection usually terminating, however, in recovery after a considerable period of invalidism. The infectious agent is usually, although not invariably, conveyed by milk. In a number of Mediterranean cities strict regulations are in force forbidding the sale of unboiled milk, and in consequence the disease has almost entirely disappeared in these places. In the United States a small area of infection exists in western Texas and New Mexico.

*Scarlet fever.*—It is considered that scarlet fever is quite frequently conveyed by milk. Numerous epidemics have been reported where practically all of the cases occurred along the route of a single dealer, the epidemics declining rapidly upon pasteurization of the milk supply. However, outbreaks of scarlet fever traced to this cause are much less common than outbreaks of typhoid fever. Perhaps one reason for this is that they are more difficult to trace to their source. The germ causing scarlet fever has never been discovered, but it is believed to exist in the secretions of the mouth and throat and one can readily understand how by careless coughing or sneezing on the part of a milker convalescent from or in the early stages of the disease the infectious agent might gain access to the milk. Some investigators have thought that the infection is at times derived from diseased cows, and there is no doubt whatever that animals suffering from inflamed udders may produce a condition in man at least simulating scarlet fever. Probably one reason why milk-borne epidemics of scarlet fever are not more common is be-

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cause the disease seldom affects adults, who for the most part are engaged in procuring and handling milk supplies.

*Tuberculosis.*—This disease is common in both man and cattle, and without doubt is the most serious illness affecting the human race. The presence of tuberculosis in man, in a certain proportion of cases, can now be definitely traced to the disease in cows, the connection being established through the use of infected milk.

The tuberculosis of cattle is more communicable in dairy herds than is tuberculosis in man. So frequent is the infection among dairy cattle that it is not unusual to find that as high as 10 per cent of market milk in some cities contains live tubercle bacilli. Bacilli may also exist for several months in butter, cheese, and cream in even greater number than in milk, so that such products, if infected, must be considered a source of danger. These organisms are necessarily derived solely from tuberculous cows, bacilli from human sources being relatively rare in milk. The germs either are given off in the milk itself or, what is believed to be more common, are contained in the feces and gain entrance to the milk during the process of milking. Unfortunately it is not always possible even for the most experienced person to detect by visual or physical examination cows which are suffering from tuberculosis, as the animals may present every appearance of health, hence it has been necessary to devise tests for this purpose. The test so used is known as the tuberculin test. The sole object of the tuberculin test is to determine what members of the dairy herd are infected with tuberculosis in order that such animals may be eliminated and their milk not offered for human consumption. Milk obtained from tuberculin-tested cattle is therefore to be considered safer than supplies otherwise produced.

While there are essential differences between human tubercle bacilli and those derived from cows, both must be regarded as dangerous to man. It is now considered that bovine bacilli, as found in milk, are only rarely a cause of tuberculosis of the lungs in adult man, the form commonly met with, although a proportion of cases of tuberculosis of organs other than the lungs is caused by this type of germ. On the other hand this same organism is known to be responsible for many cases of tuberculosis in children and some authorities estimate that at least 10 per cent of all tuberculous children owe their infection to this form of germ. From studies made it has also been learned that probably fully half of the cases of so-called surgical tuberculosis affecting children are due to this cause.

When these expressions are translated into everyday terms the gravity of the situation becomes more apparent. Many of the pale, anemic, and weakened children seen about the streets owe their

debility not alone to close confinement and lack of proper nourishment but to polluted milk. A large percentage of the maimed and crippled can attribute their deformity to bone tuberculosis and fully one-half of these little ones have derived their trouble from the milk of tuberculous cows. The cause of enlarged glands which often require removal in boys and girls, is frequently infected milk and nothing else. All of these are important and at times serious conditions, and it is somewhat startling to learn that they can be definitely traced to the consumption of a liquid which many of us have believed to be at all times entirely harmless.

*Diphtheria.*—This infection is of a different type from typhoid fever, the active agent or germ being present only in the nasal and mouth secretions of those afflicted. In the same way that we have healthy carriers of typhoid we also have healthy carriers of diphtheria, who constitute a frequent source of danger. Milk acts as a vehicle of infection in this disease but rarely, and only a small percentage of the total number of cases which develop can be attributed to this cause. However, the possibility of the development of the disease in this way must be borne in mind.

*Septic sore throat.*—This condition usually manifests itself as a tonsillitis or other form of throat inflammation and is often attended with complications which are dangerous and even at times fatal. Outbreaks are explosive in character, sometimes affecting as high as 40 per cent of the users of a particular milk supply. As in other milk-borne epidemics, children are more often attacked than adults. In nearly all cases the epidemic can be traced to the dairy and even to the particular cows responsible for the contagion. When the use of milk from this source is forbidden the epidemic ceases. The infectious agent is known to be an organism which grows in chains and this germ can be recovered from both the inflamed udders of diseased cows and from the throats of those who are made ill. Whether the infection is originally derived from man or has its source only in diseased animals is still unsettled. Even the most careful supervision of dairies may be of little avail in protecting the public against this disease.

*Foot-and-mouth disease.*—This is a highly communicable disease of cattle which very rarely affects man. The condition is of such serious economic importance to live-stock interests, however, that the most rigid quarantine measures are practiced for its suppression, and this is probably the chief reason for its infrequency in human beings. Man contracts the disease from infected cows either by actual contact or from the consumption of raw milk or any of its products, such as ice cream, butter, or even cheese. The illness in man is not of a serious nature and often goes unrecognized.

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*Diarrhea and enteritis.*—Doubtless quite the most frequent disease brought about by impure milk is diarrhea and enteritis, a common affection of infancy which annually accounts for over 65,000 deaths in the United States of children under the age of 2 years. It is true that milk can not be held entirely responsible for this frightful mortality, such conditions as overcrowding, filth, heat, and ignorance being predisposing and contributing factors, but impure milk is frequently the exciting cause, a fact which is now perfectly well established. In those cities which have carefully guarded milk supplies the infant mortality rate is generally low. It is entirely feasible for any city to protect in a measure the lives of its babies by simple regulation of the milk supply. Logically, what is true for the community is likewise true proportionately at least for the home.

The mortality among infants fed on cow's milk is ten times as great as among those nursing from their own mothers; the cause of this is not entirely the difference in the proportion of the natural ingredients of the milk, but is due in part to bacteria and filth which gain entrance thereto. It is very likely that "summer diarrhea" is in the majority of instances caused by a distinct germ, and that the conveyor of the infection is usually cow's milk, the organism gaining access to the supply in much the same manner as the typhoid bacillus.

Diarrhea and enteritis in both infants and adults may likewise be brought about by abnormal conditions of the cows themselves. Milk from animals suffering from inflammation of the digestive tract often produces symptoms in the consumer and should not be used. Inflammatory conditions of the udder are at times responsible for the appearance of gastric and intestinal derangements in children; for this reason milk derived from cows afflicted with garget or mastitis is never altogether safe, even when its appearance is entirely satisfactory. Other septic conditions in cows may likewise bring about changes in the quality of the secretion leading to at least temporary reaction in man. The tendency of milk obtained too close to the parturition period to cause looseness of the bowels is also well known.

#### The Prevention of Milk-Borne Diseases.

*Prevention of the entrance of bacteria.*—It can very readily be seen from what has been previously stated that an important consideration in the production of milk is to avoid the entrance of dirt and bacteria thereto. At first glance this would seem to be a difficult procedure and many dairymen have become discouraged over the expense involved and the prospects of its accomplishment. In reality, however, the requirements are exceeding simple, easy of application, and can be put into operation without undue expense. Any

intelligent farmer can in a short time be taught how to produce a clean sanitary milk. The principles involved do not demand that radical changes shall be made in the construction of the stables, the care of the stock, or the installation of expensive apparatus; they simply require that certain rules of cleanliness be enforced, and that the dairyman have in view the object to be attained. The following are the essentials:

1. **Healthy stock:** Good milk, of safe quality, can be secured only from healthy stock. If cows are diseased, their secretion is apt to contain abnormal constituents or even disease-producing organisms themselves. It is unnecessary to state that milk of this character should never be used by man, and that the tuberculin test and every other precaution should be exercised to prevent the distribution of such supplies. Gastroenteritis in cows, septic fevers, inflammation of the udder, and the presence of any one of a number of other diseases is invariably sufficient reason to warrant the discontinuance of the milk as a food.

2. **A careful milker:** Milk that comes in contact with the hands of the ordinary milker is not clean, and the danger of producing disease in this manner is evident. The hands should first be thoroughly washed before the milking is begun, carefully dried, and kept dry during the milking process. The milker should avoid the raising of dust and should prevent the entrance of organic matter into his containers. Carelessness in coughing, sneezing, and the dissemination of secretions is also to be avoided.

3. **Only covered or hooded milking pails should be used.** The hooded pail prevents the entrance of organic matter from the cow, the milker, and the dust contained in the air, and if it is not used the production of clean milk is impossible. So long as material of this character is intercepted by a properly constructed hood it is free from danger; once it gains access to the milk the harm has been done. The hooded milking pail, with an aperture not over 5 inches in diameter, is therefore to be considered a most important apparatus in the production of clean milk.

4. **Sterile containers only should be used.** This applies to milk pails, milk cans, strainers, or any other substance with which the milk comes in contact. The ordinary method of washing utensils with soda or soap powder removes dried milk and other gross matter, but does not kill the bacteria which are constantly present. To accomplish this the long-continued application of either steam or boiling water is necessary, the mere rinsing with hot water practiced by the average housewife not being sufficient. After the containers are washed and sterilized, they should be kept in places sheltered from dust.

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5. The milk should be properly refrigerated. The equipment necessary for cooling milk either at the dairy or elsewhere is exceedingly simple. An ordinary wooden tub or half barrel supplied with running water at a temperature not above 45° F., or filled with ice water, is all that is necessary. The rapid mechanical coolers are not required; in fact, they but increase the chances of contamination.

To those who are informed it is obvious that many of the steps commonly recommended for the production of clean milk are not enumerated in the above. For example, nothing is said regarding the cleanliness, ventilation, and lighting of the stable, its freedom from manure, the construction of floors, and the character of the milk house. In so far as these conditions have a bearing upon the health of the stock they are worthy of consideration, as in this way they indirectly affect the quality of the milk. They are also more or less of an indication of the care and cleanliness exercised in the production of pure milk. At the same time they are not essential to that production. It is possible to produce clean milk from cows which have not been carefully groomed and in stables which have not all modern equipment. If the dairyman adheres to the principles laid down regarding the health of his stock, the use of the hooded pail, the sterilizing of containers, and the refrigeration, and exercises due care, he will at least produce a fairly clean milk even if the remaining conditions are not distinctly favorable to such production. It is true that as much depends upon the milker as upon the condition of the stable, or perhaps more. However, a careful, clean dairyman will not maintain a dirty cow shed or stable.

In the transportation of milk the principles which have been outlined should also obtain. The cans should be well jacketed and not allowed to stand in the sun at any stage of their journey. During the summer season refrigeration is necessary. Supplies which are not afforded this treatment, even if perfectly sweet, should be regarded with some suspicion. Fortunately, in many instances modern transportation facilities have been of untold benefit in enabling milk to reach the consumer in a fresh and satisfactory condition, although a supply may be hauled several hundred miles before it arrives at its destination. In distributing plants even greater cleanliness and care should be exercised than at the dairy.

Milk should always be purchased in bottles and never in bulk. In progressive cities the retailing of dipped milk has been prohibited and an important source of disease conveyance thus eliminated. Bulk store milk invariably shows a much higher bacterial count and is more subject to contamination than that supplied in bottles which is distributed to the consumer or purchased in stores. With dipped store milk there is often a lack of care in both the cleaning and sterilization of utensils, usually because the facilities for this work

are not available. Refrigeration and cleanliness are also often not of the best, while frequently there is an inordinate amount of dust in the atmosphere, which readily gains access to open cans. The clerks are untrained in the principles relating to the care of milk, and occasionally the living apartments and the grocery are in close connection. All of these conditions greatly favor the entrance of bacteria to the supply and may render it unsafe for consumption.

*The care of milk in the home.*—The care of milk in the home is not the least important of the measures for disease prevention. The container should be removed to the refrigerator as soon after it is received as possible and not be permitted to stand in the sun or even remain at room temperature. The small, insulated boxes which have recently come on the market for the reception of the bottle when delivered serve a useful purpose. Refrigeration at the home is fully as necessary as at other places, and in order to insure a pure supply ice must be used. The temperature of the refrigerator ought not to be above 50° F. All surfaces should be maintained sweet and clean, inasmuch as a dirty and foul refrigerator may be responsible for bacterial contamination.

When received, the milk should preferably be retained in the bottle, but if this is impossible a clean receptacle, kept constantly covered, should be provided. Before the contents of the bottle are removed the lip should be carefully wiped off and if dirt and moisture are present on the cap their entrance to the flowing stream should be prevented. The mixture of a milk with that of a previous day's supply facilitates bacterial growth and is to be avoided. Bottles should not be employed for other purposes than as milk containers. Upon the occurrence of any contagious disease in the house, they should be returned to the dealer only with the knowledge and consent of the board of health.

*Inspection of dairies.*—In order that the measures previously outlined may be enforced, the majority of progressive communities have established what is known as dairy inspection, a procedure usually carried out by the health department. The sole object of dairy inspection is to make milk safe and thus to insure community protection against disease. To be effective, control must be exercised not only at the dairy but along the entire route from the farm to the consumer. The licensing of milk dealers is dependent upon this inspection, although too frequently licenses are granted without adequate examination of the dairy or knowledge of the character of the milk.

The ideal dairy inspection is begun in the laboratory. The bacterial count of each individual supply indicates whether the milk has been carefully produced. In case the milk is found to be satisfactory, no further action is usually deemed necessary and the dairy-

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man, after being made acquainted with the fact that he is producing a good quality of milk, is allowed to continue with the methods which he has adopted. In case the milk is found to be bad, the producer is informed to that effect and an inspection of the dairy made to determine the cause. In many instances it is found that the farmer is ignorant of the methods of producing a pure and safe milk supply, or he may be simply careless. In either case effort is made to see that he adheres to the principles which have been enumerated and which are in the main simple and inexpensive and within the reach of all. If the dealer is unwilling to correct his methods and continues to distribute a milk which is considered dangerous for consumption, his license is revoked.

Whatever the system of dairy inspection, only the most important principles should be dwelt upon. The fact that the farmer does not have a cement floor to his stable or 4 square feet of window glass per cow should not be held against him so long as he is producing clean milk. Contrariwise, if his neighbor across the way has erected a stable, with an automatic system of ventilation, yet continues to employ milkers who habitually dip their fingers in the milk or who use unsterilized strainers, there is reason enough for disapproval. From this no one should conclude that cement floors or a stable properly illuminated are not desirable; these are matters which every farmer should see the advantages of and make arrangements for at the earliest possible date. At the same time there is not the slightest necessity for delaying the production of clean milk pending the installation of equipment of this character. Clean milk can and should be produced in the average stable. In a similar manner while no one recommends a dirty barnyard and everyone trusts that the day will come when all barnyards will be clean, we should in the meantime not neglect to urge the production of milk free from the danger of conveying disease, a matter at least not entirely dependent upon such esthetic problems as the cleanliness of the cow or stable.

Supplementing the inspection system certain cities have established what is called the score-card system. The score card has two objects. One is to facilitate the orderly and systematic inspection of the dairy by the health official, the other to afford a concise written record of the conditions found. Dairies are marked on the basis of 100, each item, such as the healthfulness and condition of the stock, the proper care and chilling of the milk, being given so many credits, not all of the items having the same relative value.

In dairies which approach the ideal the total score may reach close to the 100 mark, while in those where sanitary precautions are not observed the score may fall below 40 or even 20. Records are maintained in the health department of the ratings as given from time to

time and in certain cities they are published, so that it is possible for every purchaser of milk to ascertain the sanitary status of the dairy from which he is receiving his supply. Ordinarily dairies which maintain an average rating of 80 or more may be considered good, those between 60 and 80 fair, while those which continually fall below 60 belong to a class in which the rules governing the production of safe milk are not observed. These figures are naturally somewhat dependent upon the strictness with which the scoring is done and the particular system followed. It is again to be remembered that a high score card rating does not necessarily mean a high quality of milk, an assumption far too common.

However thorough the inspection of dairies may be and regardless of the degree of care exercised, it should be realized that absolute protection against disease is not afforded by the measures outlined and that further means of safeguarding the purity of milk supplies are necessary. This may be accomplished by either of two methods.

*Pasteurization.*—The word "pasteurization" is a rather formidable name for a somewhat simple process. The majority of persons upon first hearing the term conceive of an operation incapable of being performed by the average individual. Quite the opposite is true. Pasteurization, provided the proper apparatus is at hand, is no more difficult of accomplishment than many of the processes of cooking performed by the average housewife.

The purpose of pasteurization is to kill the harmful bacteria which milk contains. It has been found that when milk is heated to a temperature of 145° F. and sustained at that point for 30 minutes the disease-causing organisms are killed. If the milk is then immediately chilled and further contamination is prevented it can no longer be considered dangerous to health. Milk which has been adequately pasteurized is therefore to be regarded as the safest milk which one can consume.

Milk may be pasteurized either at the distributing station or in the home, the ideal method being pasteurization in the final container. A number of American cities now require that all milk shall be pasteurized, so that large plants where the process is performed are common. There are a number of pasteurizers on the market for home use, but these are not essential. The milk bottles may be placed in the inner portion of an ordinary double boiler, the cold water of the smaller receptacle being on the level with the milk in the bottles. The boiler is then placed on the stove and heated until the water in the inner-dish reaches a temperature of 145° F., as determined by the thermometer, where it is maintained for 30 minutes. The bottles are then removed and cooled in running water, being kept sealed until the milk is ready to serve.

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When milk is pasteurized on a large scale certain modifications of this method are employed, but the effect produced is the same, all disease-bearing bacteria, such as the tubercle bacillus and the typhoid and diphtheria organisms, being destroyed. The difference between pasteurization and boiling is one of degree only; the former destroys only disease organisms while the latter kills practically all varieties.

The taste and appearance of pasteurized milk differ little from those of untreated milk, and the milk spoils in practically the same manner. When pasteurized milk becomes the exclusive diet of infants over a period of several months it is thought by some observers to be a factor in the production of a condition known as infantile scurvy. This disease is extremely rare, however, and many physicians deny that heated milk is concerned in its production. Scurvy, however, can always be prevented by feeding the baby a little orange juice regularly. For adults pasteurized is fully as nutritious as raw milk, and the digestibility of the two is the same.

It would seem that in pasteurization man has found a ready method for the prevention of all milk-borne diseases. The process is not expected to be a substitute for cleanliness, which prevents the access of dirt and bacteria, nor of cold which prevents their rapid increase, but merely to supplement these measures. Inspection of dairies is not to be neglected even when the milk is to be treated in this manner, pasteurization being only an additional and a more thorough safeguard which compensates for failure of inspection to afford absolute protection. The more widespread adoption of pasteurization is therefore to be urged, both for communities and for the home, as it insures a degree of protection only attained by one other measure, boiling.

*Boiling.*—The single remaining safeguard against the transmissions of disease by milk to be considered is boiling. This is of course the simplest and easiest of all processes to perform and it insures practically absolute protection against disease. For a number of reasons, however, the boiling of milk has not become popular in this country, although in Europe it is almost a universal procedure, practically all the milk fed to infants and the greater part of that consumed by adults being treated in this manner. As a consequence milk-borne diseases are far less common there than with us.

Boiling produces changes in the color of milk, retards the rising of the cream, and brings about the development of a characteristic cooked taste. Raw milk is known to contain certain vital principles which are destroyed by boiling; the absence of these principles in boiled milk is supposed by some to be responsible for scurvy in infants who are fed exclusively on milk treated in this manner, although a much more common cause is the use of proprietary foods. Never-



theless the cases of scurvy in infants which can be traced to the use of boiled milk are extremely rare. Even when fully developed the disease is strikingly curable and it is altogether preventable by the addition of a little orange juice to the diet, so that it would seem to have but little weight against the more widespread adoption of boiled milk. Inasmuch as boiled milk decomposes more rapidly than raw milk the milk should be boiled only in the home and not allowed to stand for more than a day or two before use.

Boiled milk is more constipating than raw milk and is therefore of considerable value in the treatment of diarrhea of both infants and adults. It is also more easily digested, the curds formed being smaller and softer than those of raw milk, so that it has certain advantages in the feeding of infants. For these reasons boiled milk is coming into much more general use. The single great advantage obtained from the use of boiled milk is, however, absolute freedom from the danger of contracting communicable disease. In milk which has been boiled for five minutes all organisms of a disease-producing character are killed and the supply is no longer capable of conveying the many infections which are transmitted by this substance. For these reasons boiling is to be recommended for all supplies which are suspicious as to quality and whenever there is an undue prevalence of any of the diseases mentioned. If this is done the danger of contracting disease through the use of contaminated milk altogether ceases.

#### Summary.

Milk is a chemical product composed of water, fats, proteins, sugar, and various ferments and salts. The adulterations to which it is subjected detract from the food value, but are not apt to be injurious to health, while the impurities which gain entrance accidentally are of far greater consequence. Milk harbors bacteria of many varieties and favors their growth and development. If these organisms are of the disease-producing kind serious epidemics may result, and milk has come to be regarded as a frequent cause of typhoid fever, tuberculosis, the summer diarrhea of infants, and numerous other conditions. Organisms which may bring about the development of disease may be derived either from animals or from man, the latter source perhaps being the more common. In order to prevent the contamination of milk every possible avenue of infection from the farm to the consumer must be controlled. Inspection of dairies is a proper and necessary measure, but the protection it affords against the dissemination of disease is entirely insufficient. For this reason pasteurization or boiling are to be recommended.